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ANDERSON ENGINEERING INC SPRINGFIELD MO

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NATIONAL DAM SAFETY PROGRAM, HUNT LAKE DAM (MO 31076), WHITE RA--ETC(U)

FEB 80 J M HEALY, S L BRADY, T BECKLEY

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Hunt Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Hunt Lake Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- 1) Spillway will not pass 50 percent of the Probable Maximum Flood.
- 2) Overtopping could result in dam failure.
- 3) Dam failure significantly increases the hazard to loss of life downstream

SIGNED

SUBMITTED BY: Chief, Engineering Division

26 MAR 1980

Date

SIGNED

APPROVED BY: Colonel, CE, District Engineer

26 MAR 1980

Date

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HUNT LAKE DAM
SHANNON COUNTY, MISSOURI
MISSOURI INVENTORY NO. 31076

6 PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.

Hunt Lake Dam (MO 31076), White Basin,
Shannon County, Missouri. Phase I Inspection
Report. Prepared by

Anderson Engineering, Inc. Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

15 _____ 9 Final rept.,
DACW43-79-C-0070 | 10 John M./Healy
Steven L. /Brady Tom /Beckley Gene /Wertepny
Dan /Kerns

Under Direction of
St. Louis District, Corps of Engineers

For
Governor of Missouri

11 Feb 1980

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Hunt Lake Dam
State Located:	Missouri
County Located:	Shannon County
Stream:	Tributary of Pike Creek
Date of Inspection:	24 August 1979

↓
Hunt Lake Dam was inspected by an interdisciplinary team of engineers, from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately one mile downstream of the dam. Located within this zone is the city of Winona. The zone includes about 37 dwellings and two churches within the city of Winona plus a railroad. The dam is in the small size classification, since it is less than 40 ft. high and the maximum storage capacity is greater than 50 acre-ft. but less than 1000 acre-ft.

↓
Our inspection and evaluation indicates that the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass 18 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of small size with a high →

↓
downstream hazard potential pass 50 to 100 percent of the PMF. Considering the number of dwellings immediately below the dam in the floodway, the PMF has been determined to be the appropriate spillway design flood. The 100-year frequency flood will not overtop the dam. The 100-year flood is one that has a 1 percent chance of being equalled or exceeded in any given year.

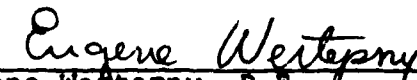
Deficiencies visually [↑]observed by the inspection team were: (1) brush and tree growth present in the spillway channel and on the embankment, (2) erosion areas in the front face of the embankment and the downstream spillway channel, (3) possible seepage area through the embankment when pool level is at or above normal pool level, and (4) several fence posts across entrance of the primary spillway. Another deficiency was the lack of seepage and stability analysis records.

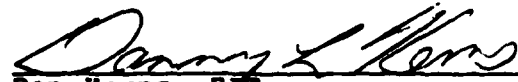
It is recommended that the owners take the necessary action in the near future to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.


John M. Healy, P.E.
Hanson Engineers, Inc.


Steven L. Brady, P.E.
Anderson Engineering, Inc.


Tom Beckley, P.E.
Anderson Engineering, Inc.


Gene Westepny, P.E.
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Hanson Engineers, Inc.



AERIAL VIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

HUNT LAKE DAM - ID No. 31076

TABLE OF CONTENTS

<u>Paragraph No.</u>	<u>Title</u>	<u>Page No.</u>
	SECTION 1 - PROJECT INFORMATION	
1.1	General	1
1.2	Description	1
1.3	Pertinent Data	3
	SECTION 2 - ENGINEERING DATA	
2.1	Design	6
2.2	Construction	7
2.3	Operation	7
2.4	Evaluation	8
	SECTION 3 - VISUAL INSPECTION	
3.1	Findings	9
3.2	Evaluation	10
	SECTION 4 - OPERATION PROCEDURES	
4.1	Procedures	12
4.2	Maintenance of Dam	12
4.3	Maintenance of Operating Facilities	12
4.4	Description of Any Warning System in Effect	12
4.5	Evaluation	12
	SECTION 5 - HYDRAULIC/HYDROLOGIC	
5.1	Evaluation of Features	13
	SECTION 6 - STRUCTURAL STABILITY	
6.1	Evaluation of Structural Stability	15
	SECTION 7 - ASSESSMENT/REMEDIAL MEASURES	
7.1	Dam Assessment	16
7.2	Remedial Measures	17

APPENDICES

APPENDIX A

Sheet

Location Map
Vicinity Map
Plan, Profile and Section of Dam
Plan Sketch of Dam

1
2
3
4

APPENDIX B

Geologic Regions of Missouri
Thickness of Loessial Deposits
SCS Soils Map

1
2
3 - 4

APPENDIX C

Overtopping Analysis - PMF

1 - 7

APPENDIX D

Photographs of Dam and Lake

1 - 6

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Hunt Lake Dam in Shannon County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Hunt Lake Dam is an earth fill structure approximately 21 ft. high and 365 ft. long at the crest. The appurtenant works consist of an earth lined spillway in the abutment at the east end of the dam. Sheet 3 of Appendix A shows a plan, profile and typical section of the embankment.

B. Location:

The dam is located in the Southeastern part of Shannon County, Missouri on a tributary of Pike Creek. The dam and lake are within the Winona, Missouri 7.5 minute quadrangle sheet (Section 13, T27N, R4W - latitude 37°00.5'; longitude 91°20.2'). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 21 ft. and a maximum storage capacity of approximately 57 acre-ft., the dam is in the small size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. The estimated damage zone extends approximately one mile downstream of the dam. Located within the damage zone are about 37 dwellings and two churches located within the city of Winona plus a railroad.

E. Ownership:

The dam is owned by Mrs. Mabel Hunt. The owner's address is Box 266, Peculiar, Missouri 63629. (Telephone number is 816-758-5388).

F. Purpose of the Dam:

The dam was constructed primarily for watering livestock.

G. Design and Construction History:

The contractor for the project was Mr. Sherman Dailey (telephone 314-325-4257). The information contained in this paragraph was obtained from Mr. Dailey. The Hunt Lake Dam was constructed in 1963. Material from the existing farm pond on the site was removed and spread over the downstream floodplain. A cutoff trench ten ft. wide and about four ft. deep was excavated to clay material and clay from the lake area was used to fill the trench. The embankment was constructed from silty clay soils from the lake area. Representatives from the Department of Agriculture Soil Conservation Service office surveyed the site prior to construction and checked the dam after completion (although no information was found in the files of SCS). Spillways on natural earth were constructed at each abutment. The west spillway was built one ft. higher than the east spillway. At a later date the west spillway was closed off by extending the embankment into the west abutment. According to the contractor, a 1 1/4 in. diameter pipe with a downstream valve was installed near the center of the embankment. This pipe was not found during the field inspection.

H. Normal Operative Procedures:

Normal flows are to be passed by the spillway on the east abutment. The maximum pool level was reported to have been within a foot of the crest of the dam.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 113 acres.

B. Discharge at Dam Site:

- (1) All discharge at the dam site is through an uncontrolled spillway.
- (2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 941.1 ft., MSL): 170 cfs
- (3) Estimated Capacity of Primary Spillway: 170 cfs
- (4) Estimated Experienced Maximum Flood at Dam Site: 60 cfs
- (5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable
- (6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable
- (7) Gated Spillway Capacity at Pool Elevation: Not Applicable
- (8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

- (1) Top of Dam: Low Point: 941.1 ft., MSL, High Point 941.7 ft., MSL.

- (2) Principal Spillway Crest: 939.1 ft., MSL
- (3) Emergency Spillway Crest: Not Applicable
- (4) Principal Outlet Pipe Invert: Not Applicable
- (5) Streambed at Centerline of Dam: 921.0 ft., MSL
- (6) Pool on Date of Inspection: 936.52 ft., MSL
- (7) Apparent High Water Mark: 940.1 ft., MSL
- (8) Maximum Tailwater: Unknown
- (9) Upstream Portal Invert Diversion Tunnel: Not Applicable
- (10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

- (1) At Top of Dam: 1360 ft.
- (2) At Principal Spillway Crest: 1100 ft.
- (3) At Emergency Spillway Crest: Not Applicable

E. Storage Capacities:

- (1) At Principal Spillway Crest: 42 Acre-ft.
- (2) At Top of Dam: 57 Acre-ft.
- (3) At Emergency Spillway Crest: Not Applicable

F. Reservoir Surface Areas:

- (1) At Principal Spillway Crest: 7 Acres
- (2) At Top of Dam: 9 Acres
- (3) At Emergency Spillway Crest: Not Applicable

G. Dam:

- (1) Type: Rolled Earth
- (2) Length at Crest: 365 ft.

- (3) Height: 21 ft.
- (4) Top Width: 12 ft.
- (5) Side Slopes: Upstream to water edge from 3.33H:IV to 3.60H:IV Downstream from 2.03H:IV to 2.63H:IV
- (6) Zoning: Homogeneous
- (7) Impervious Core: Unknown
- (8) Cutoff: Communication with Mr. Sherman Dailey, the contractor, indicates that a trench ten ft. wide and about four ft. deep was excavated to clay and filled with clay from the lake area.
- (9) Grout Curtain: Unknown

H. Diversion and Regulating Tunnel:

- (1) Type: None
- (2) Length: None
- (3) Closure: None
- (4) Access: None
- (5) Regulating Facilities: None

I. Spillway:

I.1 Principal Spillway:

- (1) Location: East abutment
- (2) Type: Earth swales

I.2 Emergency Spillway:

- (1) Location: None
- (2) Type: Not Applicable

I. Regulating Outlets:

A 1 1/4 in. diameter drawdown pipe was installed according to the contractor. The pipe was near the center of the dam and had a valve at the downstream outlet. This pipe was not located during the field inspection.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No design information on this dam was found. According to the contractor the Department of Agriculture Soil Conservation Service office at Eminence surveyed the site. The SCS office did not have any design information on the dam. No documentation of construction inspection records have been obtained. To our knowledge, there are no documented maintenance and operation data.

A. Surveys:

No information regarding pre-construction surveys was able to be obtained. The top of the concrete post support at Sta. 4+65, 30 ft. right of centerline, was used as datum for our site survey. From photographs and quad sheets the mean sea level elevation of this datum was estimated to be 943.76.

B. Geology and Subsurface Materials:

The site is located in the Southeastern portion of the Ozarks geologic region of Missouri. The Ozarks are characterized topographically by hills, plateaus and deep valleys. The most common bedrock types are dolomite, sandstone and chert. Information supplied by the Missouri Geological Survey indicates that the lake area is underlain by the Roubidoux formation of the Canadian Series in the Ordovician System. The Roubidoux formation consists of sandstone, dolomitic sandstone and cherty dolomite. The publication "Caves of Missouri" lists a total of 18 caves known to exist in Shannon County. All of these caves are located several miles from the site.

The "Geologic Map of Missouri" indicates the nearest fault to be approximately 20 miles northeast of the site. The Missouri Geological Survey has indicated that the faults in this area are generally considered to be inactive and have been for several hundred million years (rock associated with the Ordovician Period - 500 million years old).

Soils in the area of the dam site appear to be primarily thick deposits of residual silty clays with rock fragments. The soils are of the Clarksville-Fullerton-Talbott Soil Association and have developed from thin loessial soils

deposited over weathered material from sandstones and cherty dolomites. The loessial thickness map indicates that upland areas may have up to 2.5 ft. of loess cover.

Numerous sinkholes exist within a one mile radius of the dam. Many of the sinks are broad and hold water. A very large sink is located approximately one half mile southwest of the dam. No sinks were observed immediately adjacent to the dam or lake.

C. Foundation and Embankment Design:

No foundation or embankment design information was available. Information from the contractor indicates that the dam was constructed from the silty clay soils from the lake area after the material from the previous pond was removed. There is apparently no particular zoning of the embankment and no internal drainage features are known to exist. No construction inspection test results are available.

D. Hydrology and Hydraulics:

No hydraulic and hydrologic design data were available. Based on a field check of spillway dimensions, embankment elevations and a check of the drainage area on the U.S.G.S. quad sheets, hydrologic analysis using U.S. Army Corps of Engineers guidelines were performed and appear in Appendix C. It was concluded that the structure will pass 18 percent of the Probable Maximum Flood without overtopping. The 100-year frequency flood will not overtop the dam.

E. Structure:

There are no appurtenant structures associated with the dam. A 1 1/4 in. diameter pipe with valve on the downstream face of the embankment was reportedly installed through the embankment, although visual inspection of the dam did not confirm the pipes presence.

2.2 CONSTRUCTION:

No construction inspection data were available.

2.3 OPERATION:

No operating records were available. Inspection indicates that maintenance of the dam is not done regularly.

Some brush is starting to grow on the embankment and in the spillway channel. Erosion areas on the upstream face of the embankment and in the spillway channel were observed.

2.4 EVALUATION:

A. Availability:

No engineering data, seepage or stability analyses, or construction test data were available.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on 24 August 1979. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Tom Beckley P.E.- Anderson Engineering, Inc. (Civil Engineer)
Steve Brady P.E.- Anderson Engineering, Inc. (Civil Engineer)
John Healy P.E.-Hanson Engineers, Inc. (Geotechnical Engineer)
Gene Wertepny P.E.- Hanson Engineers, Inc. (Hydrologic and Hydraulic Engineer)
Dan Kerns E.I.T.- Hanson Engineers, Inc. (Geotechnical Engineer)

B. Dam:

The embankment of the dam appears to be in generally good condition. No sloughing or obvious seepage through the embankment was observed. Seepage has been reported when the lake is at or above normal pool. This area was believed to be near the toe of the embankment near the mid point of the dam. On the date of inspection, the lake level was about 2.5 ft. below normal pool, and no evidence of seepage was noticed. The dam was constructed with a gentle curve which is concave to the downstream direction. The dam is fairly level across the crest, and no surface cracking or unusual movement was noted. Shallow auger probes into the embankment indicated the top portion of the embankment to consist of fine to coarse sand, pebbles and cobbles in a brown fine sandy silty clay matrix. There was no noticeable serious erosion on the embankment. Some minor erosion was noted on the upstream face of the embankment near the east abutment. No erosion protection was provided on the front face.

Both sides of the embankment and the crest are heavily weed covered. Some tree growth is present both on the upstream and downstream face of the embankment.

No animal burrows were detected, although some could exist in the areas of heavier brush and weeds. No riprap exists on the front face of the embankment.

No seepage was detected through the embankment. The water level at the time of inspection was approximately 2.6 ft. below normal pool level (primary spillway crest). Aerial photos Nos. 1, 2 and 3 were taken in late June and show the water to be near the spillway crest.

No instrumentation (monuments, piezometers, etc.) was observed.

C. Appurtenant Structures:

C.1 Primary Spillway:

The primary spillway is an earth swale located in the east abutment. The approach to the spillway is relatively clear; however, several old fence posts are across the entrance. No non-erodible control section is provided for the protection of the spillway. Significant erosional damage has occurred in the outlet channel. A berm separates the discharge channel from the dam and discharges would not be expected to damage the embankment. The berm could however erode out with time if the channel is not maintained.

C.2 Emergency Spillway:

None

D. Reservoir:

The watershed is primarily pastureland and scattered residential areas. The slopes adjacent to the lake areas are moderate, and no sloughing or serious erosion was noted. The reservoir appears to receive a considerable amount of siltation from the watershed.

E. Downstream Channel:

The discharge channel has considerable erosion, and the sides of the channel are lined with tree and brush growth.

3.2 EVALUATION:

Tree and brush on the dam constitute a potential seepage hazard and encourage animal burrowing. Wave protection is not provided for the upstream face of the embankment. The spillway channel has eroded due to lack of a non-erodible control section. Progressive erosion could lower the elevation of the spillway, and thus lower the normal pool elevation.

tion of the reservoir. Uncorrected spillway erosion could breach the natural earth berm separating the spillway from the downstream face of the embankment. The tree and brush growth and the fence posts in the spillway channel can restrict flood flows. The purported seepage area on the downstream face of the dam should be checked during a period of high lake level.

All of the deficiencies should be corrected under the direction of an engineer experienced in the design and construction of dams.

Because of numerous sinkholes in the area, it is possible that the lake level could be affected by seepage through a sink within the lake area.

Photographs of the dam, appurtenant structures, and the reservoirs, and the watershed are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no controlled outlet works for this dam, except for the drawdown pipe. The spillway is uncontrolled, so that the pool is normally affected by rainfall, runoff, evaporation, seepage, and the capacity of the earth spillway. A 1 1/4 in. diameter drawdown pipe was reportedly installed in the embankment during construction; however, the pipe was not seen during the field inspection.

4.2 MAINTENANCE OF DAM:

There does not appear to be any regular maintenance of the dam. To our knowledge, there have not been any repairs made to the dam.

4.3 MAINTENANCE OF OPERATING FACILITIES:

No operating facilities are present on this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The tree and brush growth on the dam, erosional areas in the front face of the embankment and spillway channel, lack of erosion protection for the upstream face of the dam, lack of a non-erodible control section for the spillway outlet channel, fence posts in the spillway entrance, and the tree and brush growth in the downstream channel are serious deficiencies which should be corrected. To avoid creating an unsafe condition, corrections should be made under the direction of an engineer experienced in the design and construction of dams.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. & B. Design and Experience Data:

The hydraulic and hydrologic analyses were based on: (1) a field survey of spillway dimensions and embankment elevations; and (2) an estimate of the pool and drainage areas from the U.S.G.S. quad sheet. A resident who lives near the dam indicated that the high water this spring was within one foot of the top of the dam and that there is leakage through the dam at high lake levels. Our hydrologic and hydraulic analyses using U.S. Army Corps of Engineers guidelines appears in Appendix C.

C. Visual Observations:

The channel of the primary spillway contains tree and brush growth and has significant erosion. The spillway channel is away from the dam, and spillway releases would not be expected to endanger the dam if erosional damage is repaired on a regular basis. Several fence posts exist across the entrance to the primary spillway.

D. Overtopping Potential:

Based on the hydrologic and hydraulic analysis presented in Appendix C, the spillway will pass 18 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief Engineers, require that this structure (small size with high downstream hazard potential) pass 50 percent to 100 percent of the PMF, without overtopping. Considering the number of dwellings immediately below the dam in the floodway, the PMF has been determined to be the appropriate spillway design flood. The structure will pass a 100-year frequency flood without overtopping.

The routing of the PMF through the spillway and dam indicates that the dam will be overtopped by 1.95 ft. at elevation 943.05 ft., MSL. The duration of the overtopping will be 6.25 hours, and the maximum outflow will be 2355 cfs. The maximum discharge capacity of the spillway is 170

cfs. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

No design and construction data were obtained for this dam. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

The emergency spillway which was constructed at the west abutment was filled after the dam was completed. To our knowledge, no additional post-construction changes have been made to the dam.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition. Several items were noted during the visual inspection which should be corrected or controlled. These items are: (1) erosion of the front face of the embankment near the east abutment, (2) erosion of the downstream channel of the spillway, (3) tree and brush growth on the embankment and spillway channel, (4) reported seepage through the embankment when the reservoir is at or above normal pool elevation, and (5) fence posts across entrance of primary spillway. Another deficiency was the lack of seepage and stability analysis records.

The dam will be overtopped by flows in excess of 18 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to a failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will deteriorate and possibly could become serious in the future.

The item recommended in paragraph 7.2A should be pursued on a high priority basis.

D. Necessity for Phase II:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

A. Alternatives:

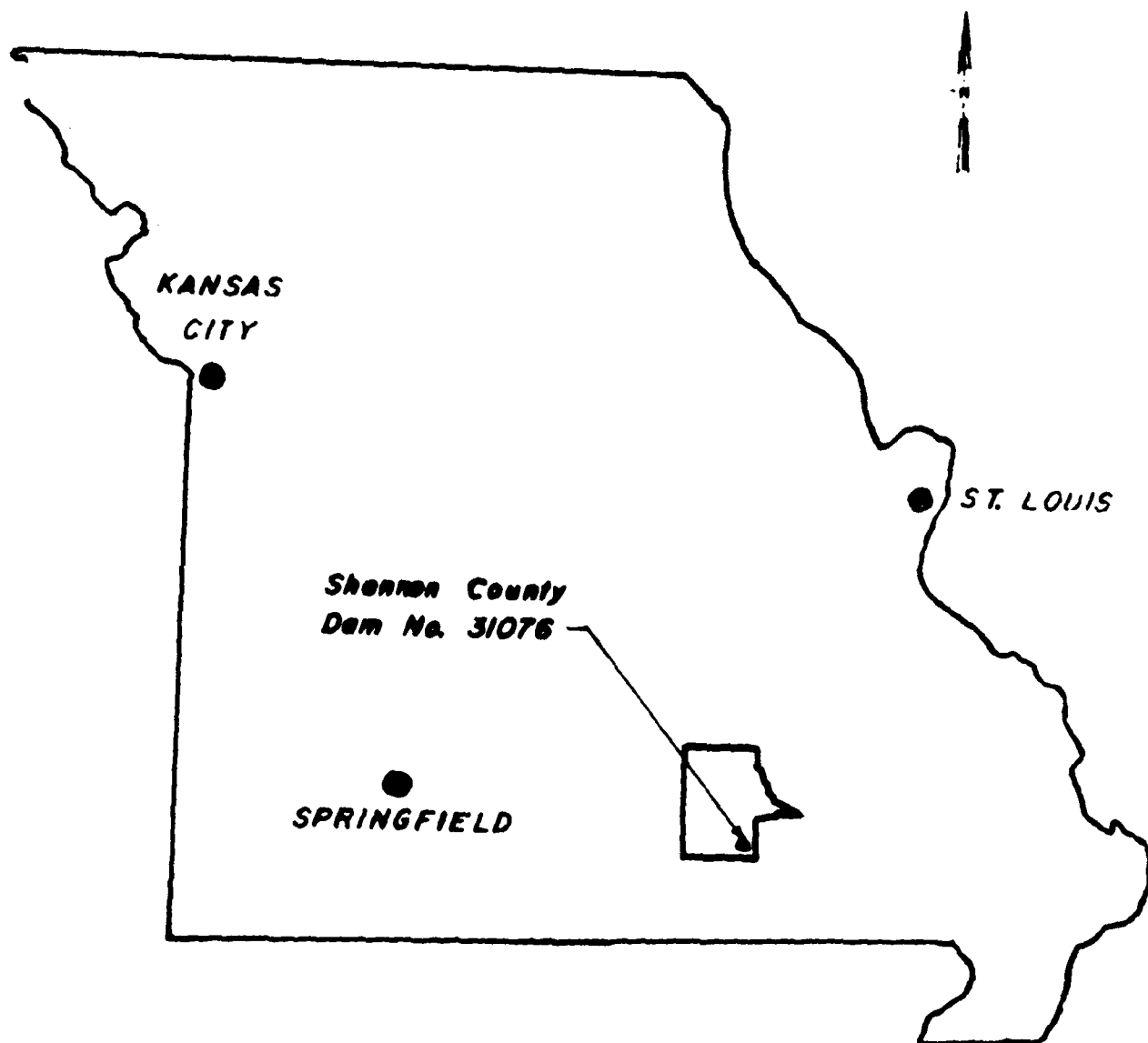
Spillway size and/or height of dam should be increased to pass the PMF. In either case, the spillway should be protected to prevent erosion.

B. O & M Procedures:

- (1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams.
- (2) Brush and tree growth should be removed from the dam and spillway channel.
- (3) Erosional areas on the front face of the embankment and in the spillway discharge channel should be repaired and maintained.
- (4) The purported seepage area through the embankment should be investigated and evaluated when the reservoir is at or above normal pool elevation by a professional engineer experienced in the design and construction of dams.

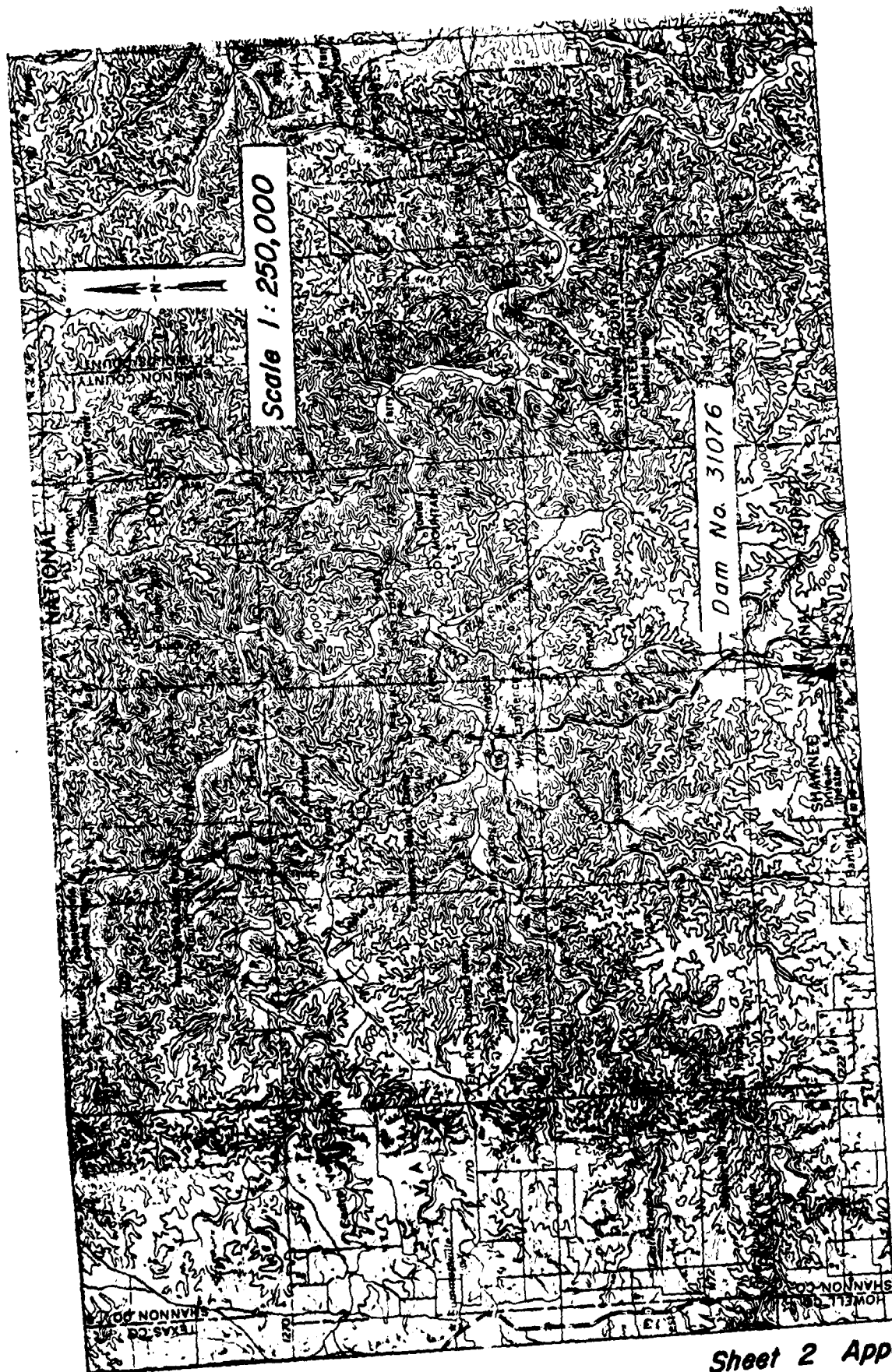
- (5) Non-erodible control sections should be provided for the spillway so that progressive erosion of the spillway will not lower the normal pool of the reservoir.
- (6) Protection from wave erosion should be provided for the upstream face of the embankment.
- (7) Fence posts at the entrance to the primary spillway should be removed.
- (8) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

APPENDIX A

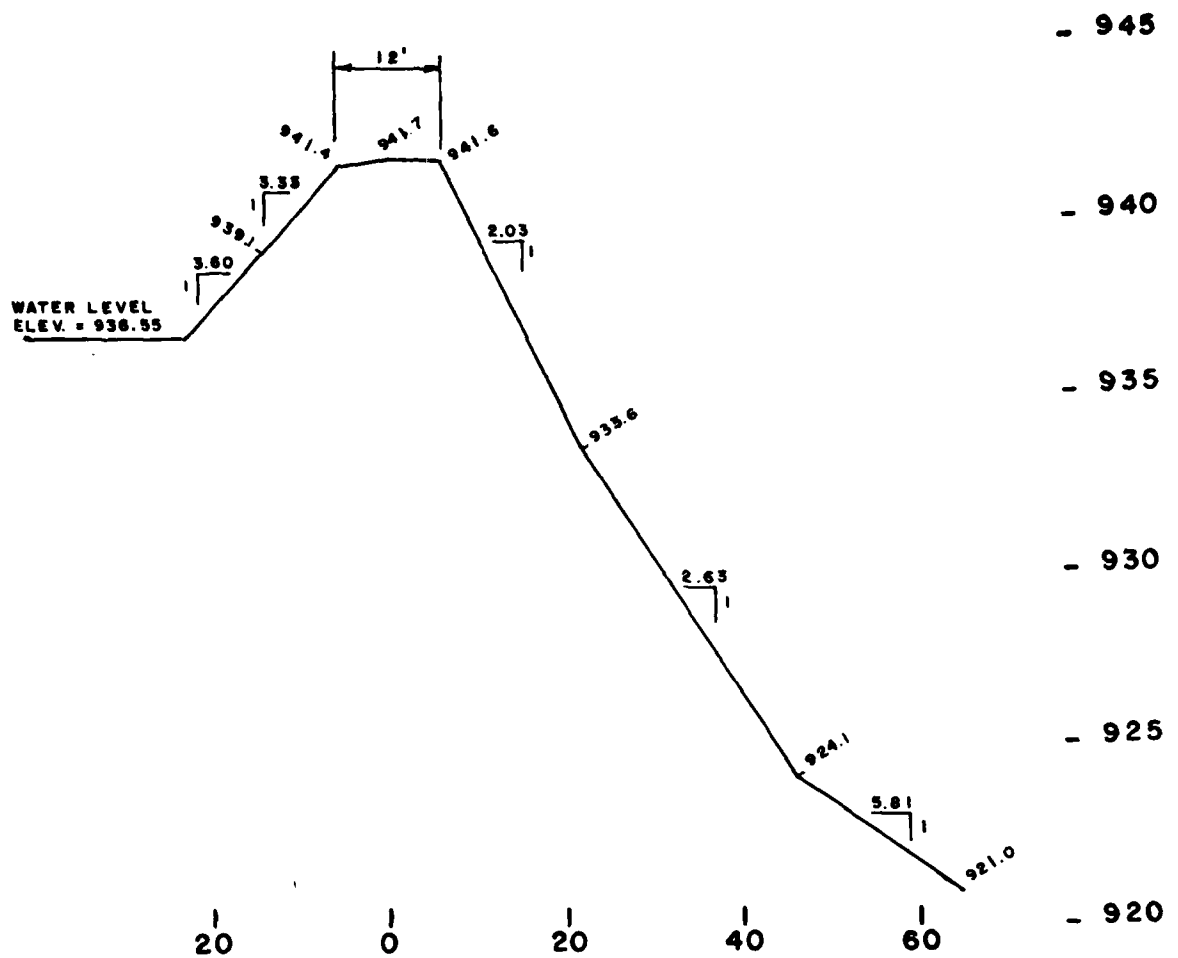


LOCATION MAP

SHEET 1 OF APPENDIX A



SITE VICINITY MAP



Sheet 3 of Appendix A

ANDERSON ENGINEERING, INC.
730 NORTH BENTON AVENUE
SPRINGFIELD, MISSOURI 65802

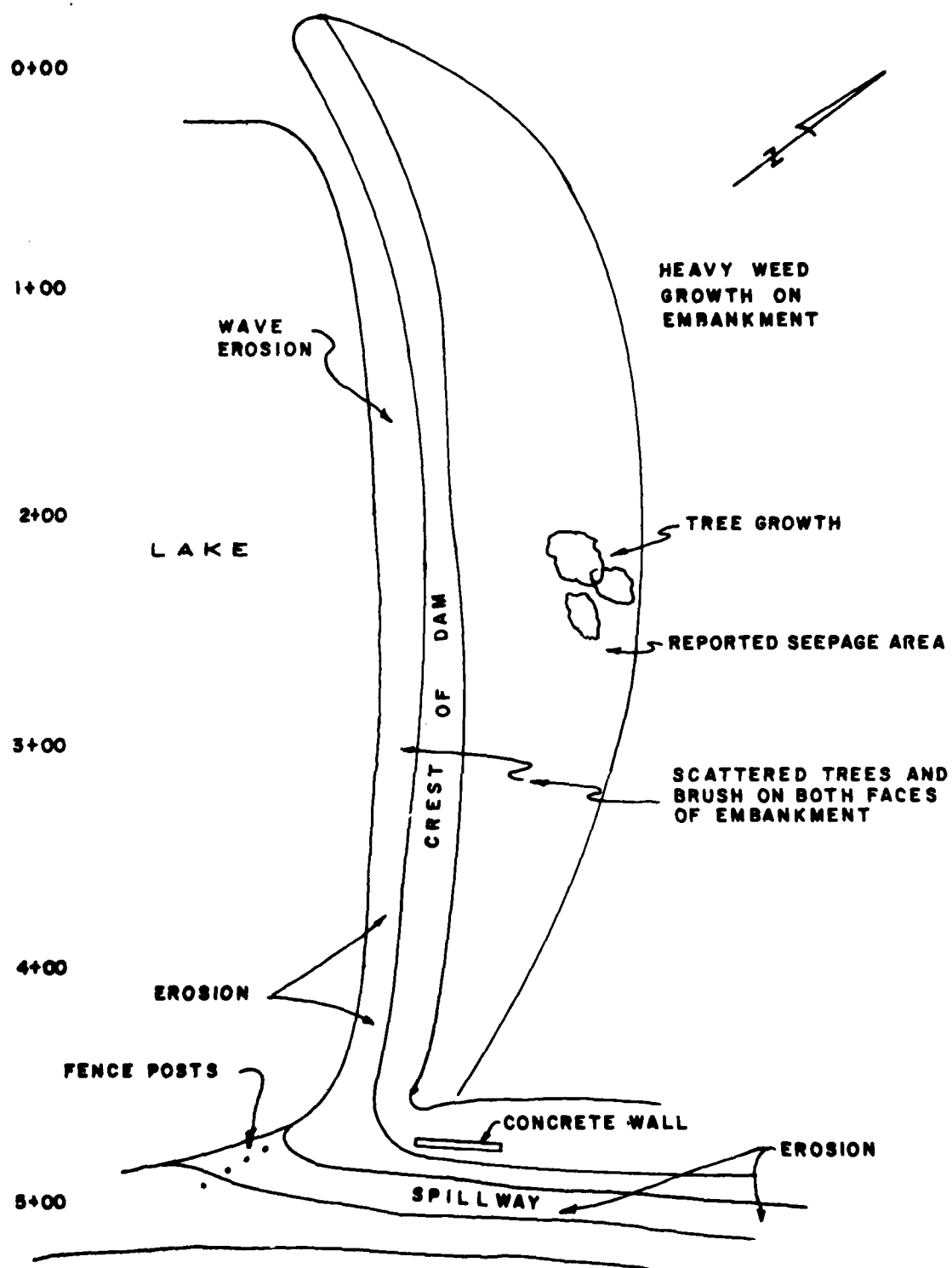
HUNT LAKE DAM

MO. No. 31076

PLAN & PROFILE

SHANNON COUNTY, MO.

2

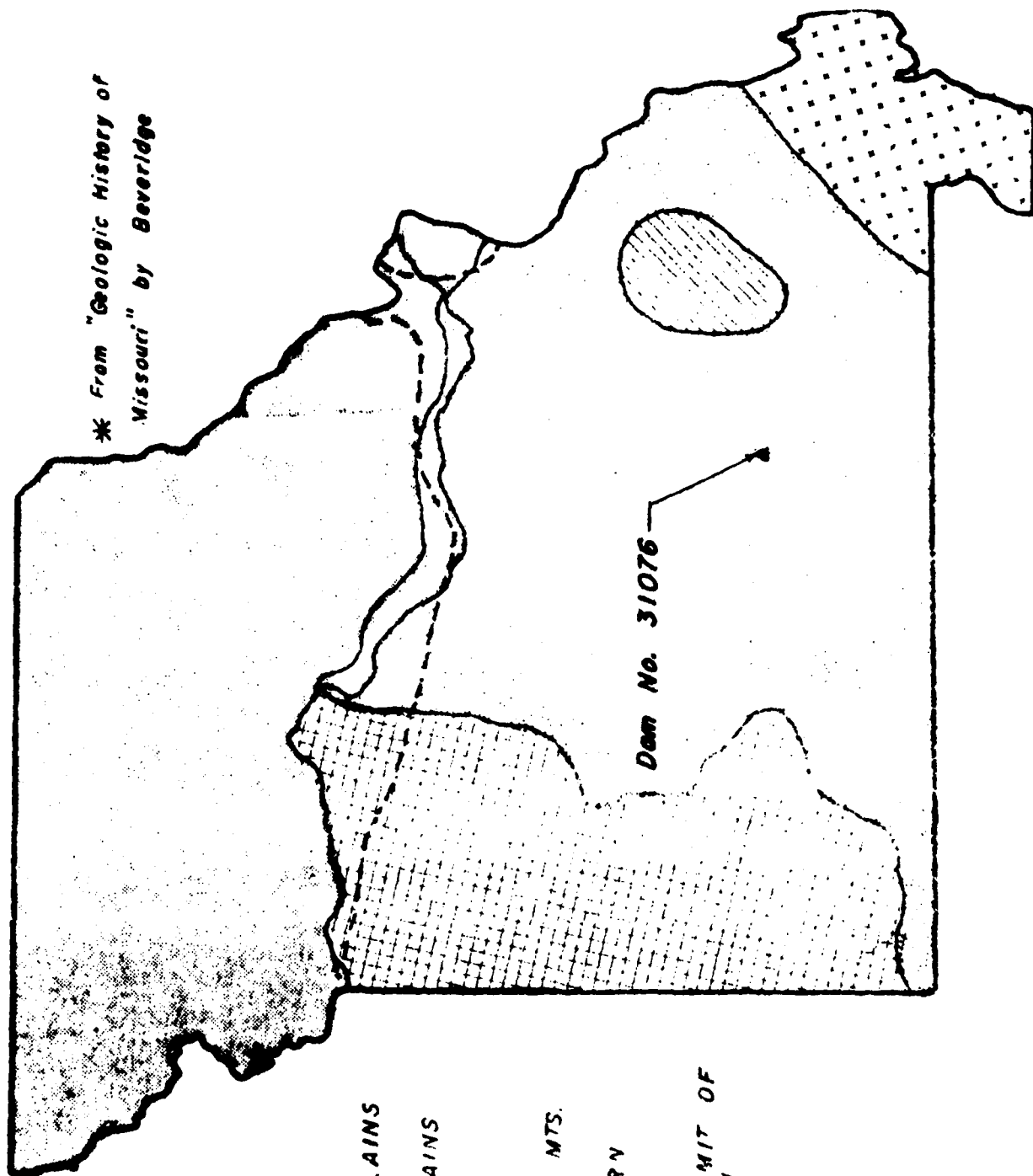


PLAN SKETCH
INSPECTION OBSERVATION
DAM No. MO. 31076

APPENDIX B

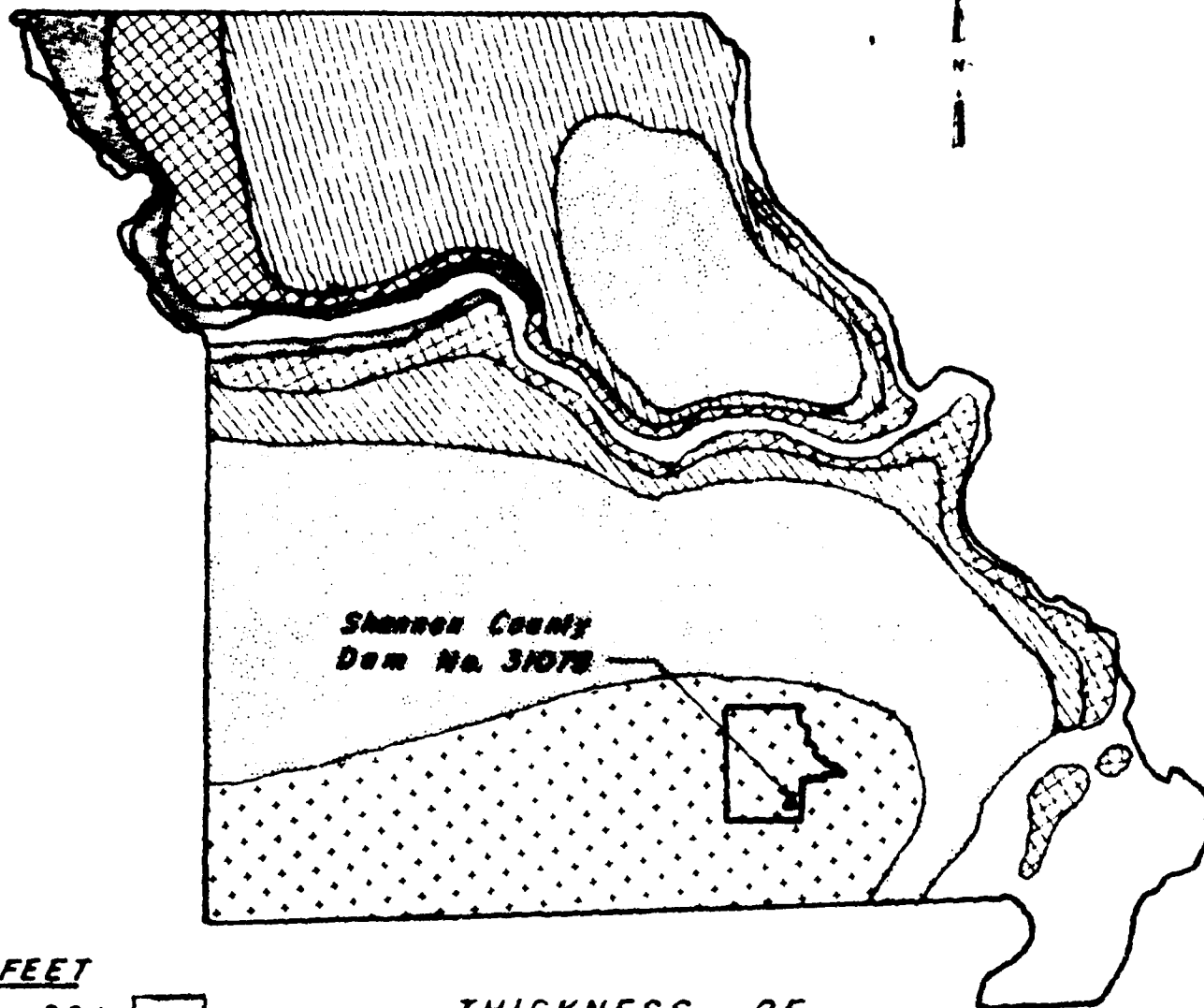
MAJOR GEOLOGIC REGIONS OF MISSOURI






* From "Geologic History of Missouri" by Beveridge



- GLACIATED PLAINS
- WESTERN PLAINS
- OZARKS
- ST. FRANCOIS MTS.
- SOUTHEASTERN LOWLANDS
- SOUTHERN LIMIT OF GLACIATION

* From "Soils of Missouri"



<u>FEET</u>	
20+	
10-20	
5-10	
2.5-5	
2.5-	

THICKNESS OF
LOESSIAL DEPOSITS

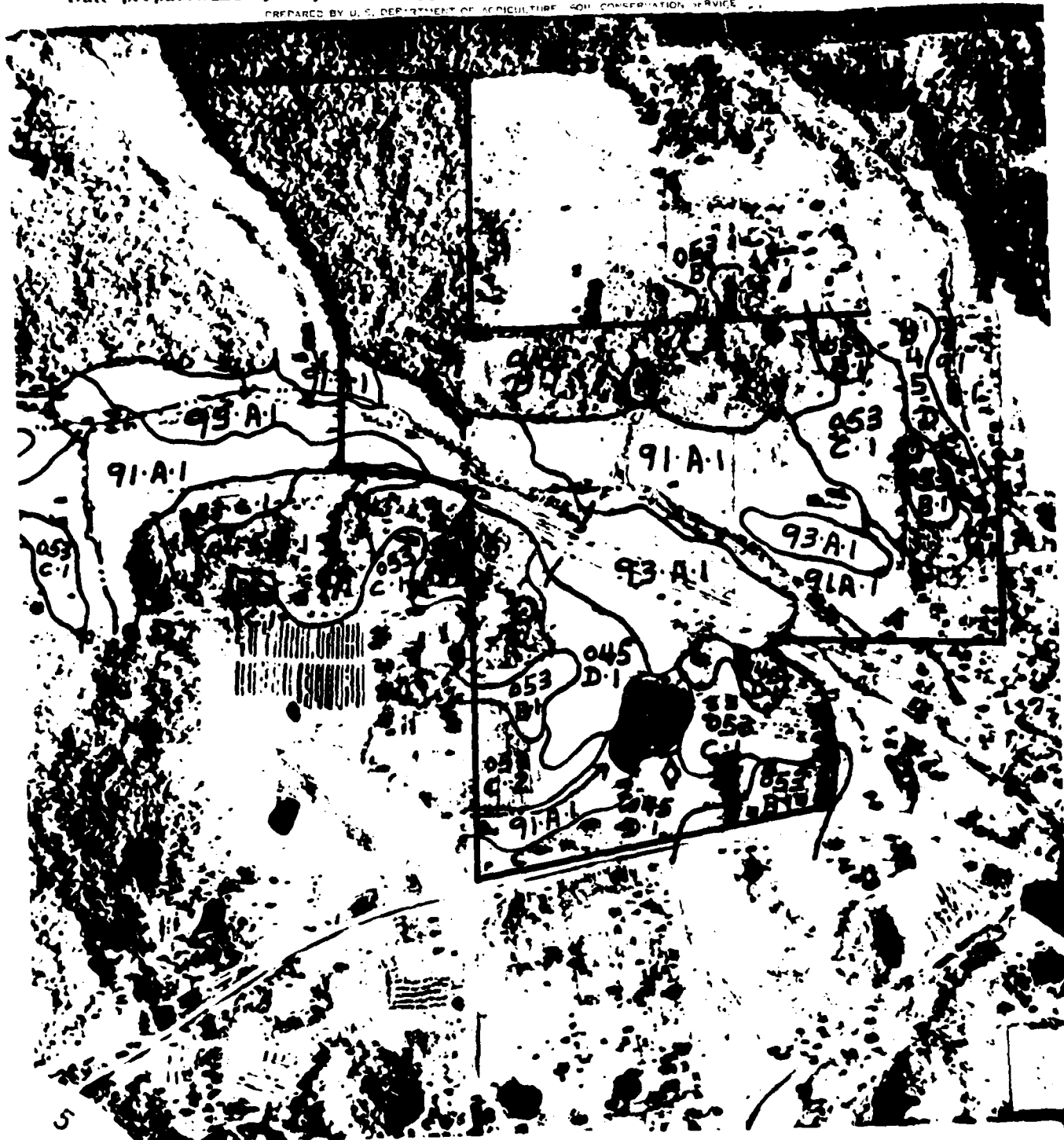
SHEET 2 OF APPENDIX B

SOIL AND CAPABILITY MAP

Soil Conservation District and
cooperating.

Owner Yandall Hunt Operator _____
County Shannon State Mo. Photo Nos. DYQ 7-36
Date prepared 1/64 Approx. Scale 8" = 1 Mile

PREPARED BY U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE



Sheet 3 of Appendix B

SOILS DESCRIPTIONS
YANDALL HUNT

9I-A-I and 93-A-I

Deep, somewhat excessively drained, gravelly, nearly level to gently sloping (0-5%) bottom land soils with low available water capacity.

045
D-I

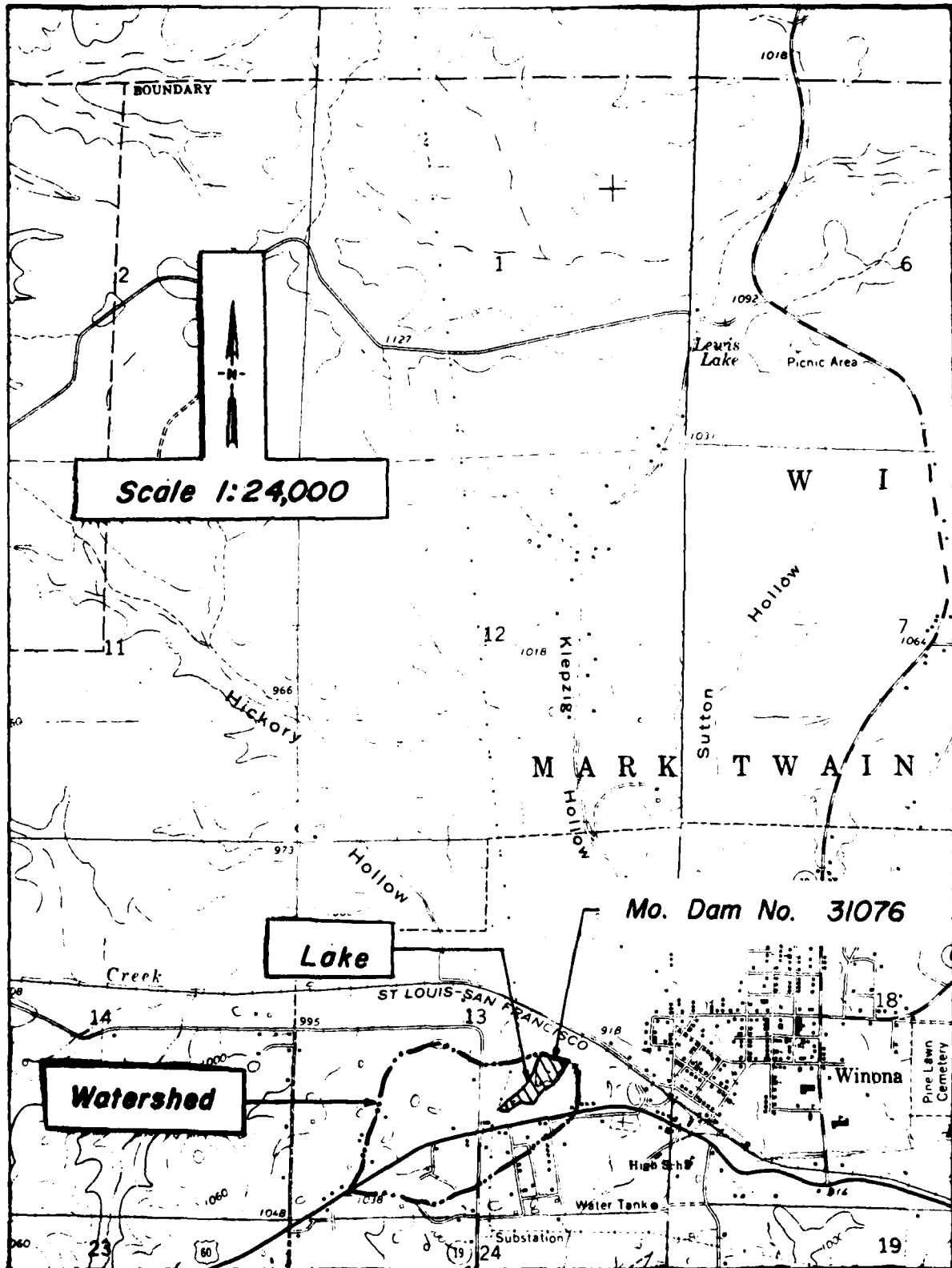
Stony and very stony soils (stony classes 2 and 3) All slope ranges are included. The available water capacity is very low.

053 and 053 and 053
B-I C-I C-2

Moderately well and well drained, cherty surfaces and subsoils over a cherty fragipan, gently sloping (2-5%) soils with very low available water capacity.

APPENDIX C

From Winona 7.5' Quad



LAKE AND WATERSHED MAP

Sheet 1 Appendix C

HYDRAULICS AND HYDROLOGIC DATA

Design Data: From Field Measurements and Computations

Experience Data: No records are available. A resident of the area, who lives near the dam, indicated the high water this spring was within one foot of the top of the dam and that there is leakage thru the dam at high pool stages.

Visual Inspection: At the time of inspection, the pool level was approximately 2.6 ft. below normal pool.

Overtopping Potential: Flood routings were performed to determine the overtopping potential. The watershed and the reservoir surface areas were obtained by planimeter from the U.S.G.S. Winona, Missouri 7.5 minute quadrangle map. The storage volume was developed from this data. A 5 minute interval unit graph was developed for the watershed, which resulted in a peak inflow of 581 c.f.s. and a time to peak of 9 minutes. Application of the probable maximum precipitation, minus losses resulted in a flood hydrograph peak inflow of 2694 c.f.s. Rainfall distribution for the 24 hour storm was according to EM 1110-2-1411.

Based on our analyses, the spillway will pass 18 percent of the Probable Maximum Flood (PMF). The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that the structure (small size with high downstream hazard potential) pass 50 to 100 percent of the PMF, without overtopping. Considering the number of dwellings immediately below the dam in the floodway, the PMF has been determined to be the appropriate spillway design flood.

The routing of the PMF through the spillway and dam indicates that the dam will be overtopped by 1.95 ft. at elevation 943.05. The duration of the overtopping will be 6.25 hours, and the maximum outflow will be 2355 c.f.s. The maximum discharge capacity of the spillway is 170 cfs. Analysis of the data indicates that the 100-year frequency flood will not overtop the dam. The computer input, output and hydrograph for the PMF are presented on Sheets 5, 6 and 7 of Appendix C.

OVERTOPPING ANALYSIS FOR HUNT LAKE DAM

INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1); Dam Safety Version Was Used.

Hydraulic Inputs Are as Follows:

- a. Twenty-four Hour Rainfall of 27.1 Inches for 200 Square Miles - All Season Envelope
- b. Drainage Area = 113 Acres; = 0.18 Square Miles
- c. Travel Time of Runoff 0.18 Hrs.; Lag Time 0.11 Hrs.
- d. Soil Conservation Service Soil Group B
- e. Soil Conservation Service Runoff Curve No. 82 (AMC III)
Soil Conservation Service Runoff Curve No. 65 (AMC II)
- f. Proportion of Drainage Basin Impervious .10

2. Spillways

- a. Primary Spillway: Trapezoidal earth channel.
Crest Length 14 ft.; Side Slopes Vary; C = Varies
- b. Emergency Spillway: None
Length ----; Side Slopes ----; C = ----
- c. Dam Overflow
Length 365 ft.; Crest El. 941.1; C = Varies

3. Spillway and Dam Rating:

Curve Prepared by Hanson Engineers. Data Provided to Computer on Y4 and Y5 Cards. (See sheet 5 Appendix C)

Formula Used:

Spillway and Dam: $\frac{Q^2}{g} = \frac{A^3}{T}$

Note: Time of Concentration From Equation $T_c = \frac{(11.9 L^3)^{.385}}{(H)^{.385}}$

California Culvert Practice, California Highways and
Public Works, September, 1942.

SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph
 - a. Peak - 581 c.f.s.
 - b. Time to Peak 9 Min.
2. Flood Routings Were Computed by the Modified Puls Method
 - a. Peak Inflow
50% PMF 1347 c.f.s.; 100% PMF 2694 c.f.s.
 - b. Peak Elevation
50% PMF 942.30; 100% PMF 943.05
 - c. Portion of PMF That Will Reach Top of Dam
18%; Top of Dam Elev. 941.1 ft.

Computer Input and Output Data are shown on Sheets 5 and 6
of this Appendix.

```

A      OVERTOPPING ANALYSIS FOR ** DAM ( # 11 )
A      STATE ID NO. 31076 CO. NO. 203 CO. NAME SHANNON
A      HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 79511
B      300
B1     5
J      1      7      1
J1     .15     .20     .30     .40     .50     .75     1.0
K      0      1
K1     INFLOW HYDROGRAPH COMPUTATION **
M      1      2      0.18      0.18      1
P      0      27.1      102      120      130
T
T2     0.18     0.11
X      0      -.1      2
K      1      2
K1     RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE **
Y      1      1
Y1     1
Y4     939.1    940.0    941.1    942.0    943.0    944.0    945.0
Y5     0      50      170      640      2230      4980      8650
9A     0      7      25.7
9E     921.0    939.1    960.0
99     939.1
9D     941.1
K      99

```

P.M.F. INPUT DATA
Sheet 5, Appendix C

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS						
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7
HYDROGRAPH AT	1	0.18	1	404.	539.	808.	1077.	1347.	2020.	2694.
	(	0.47)	(	11.44)	(15.25)	(22.88)	(30.51)	(38.14)	(57.21)	(76.27)
ROUTED TO	2	0.18	1	151.	269.	514.	846.	1123.	1737.	2355.
	(	0.47)	(	4.29)	(7.62)	(14.55)	(23.95)	(31.79)	(49.18)	(66.68)

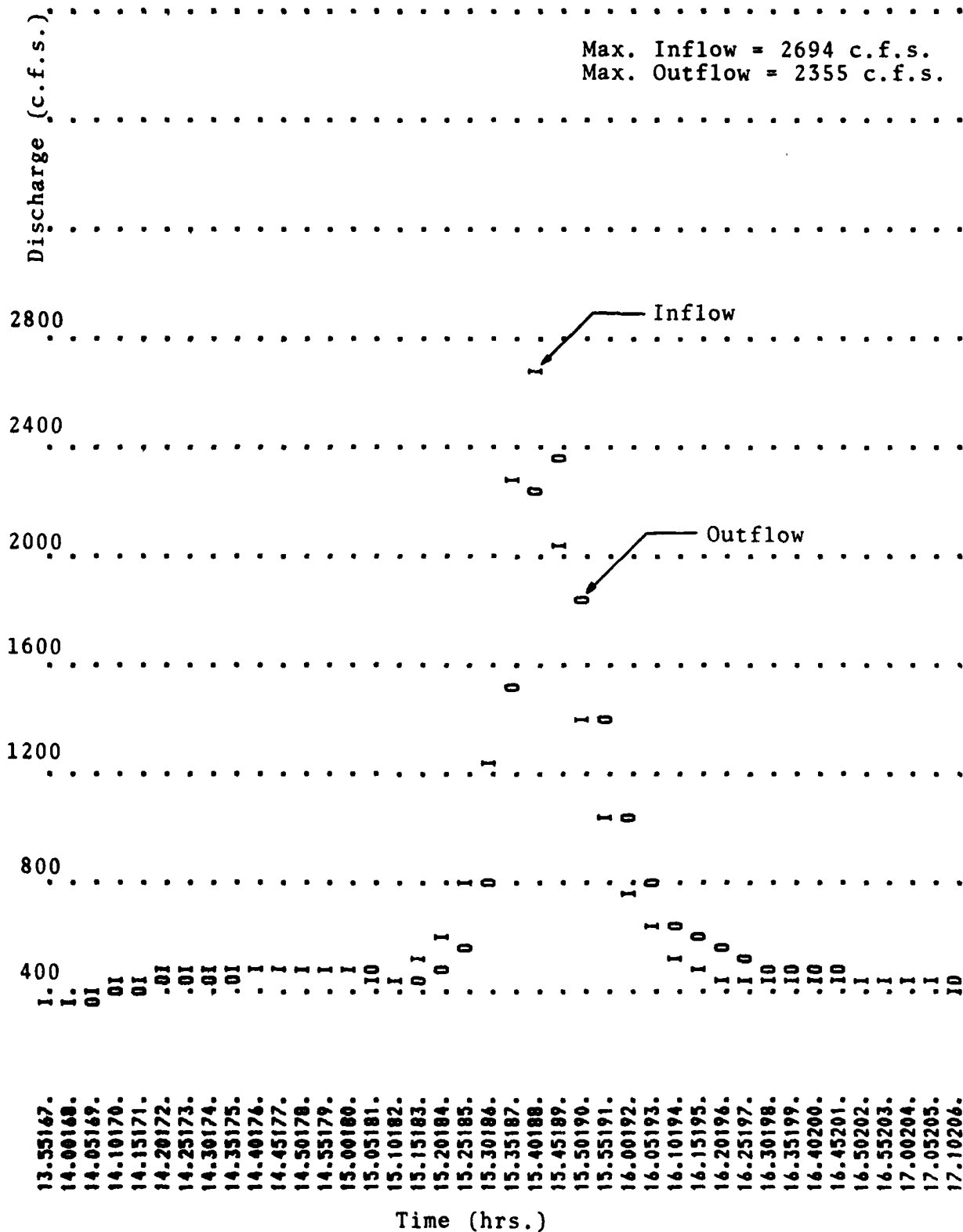
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE		SPILLWAY CREST		TOP OF DAM	
ELEVATION		939.09		939.10		941.10	
STORAGE		42.		42.		57.	
OUTFLOW		0.		0.		170.	

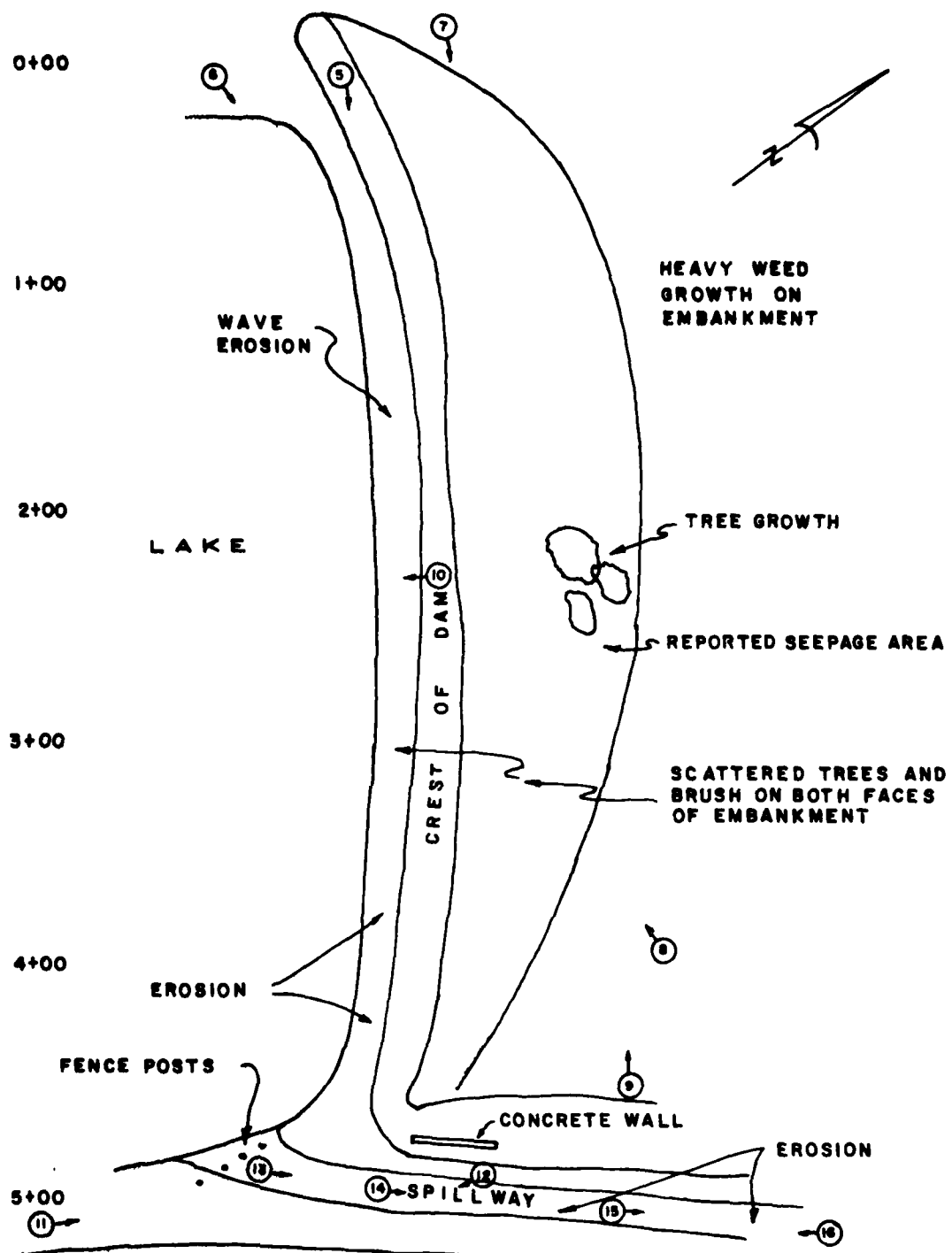
RATIO OF PHF	MAXIMUM RESERVOIR U.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW		TIME OF FAILURE HOURS	
						HOURS		HOURS	
0.15	940.93	0.00	56.	151.	0.00	15.92		0.00	
0.20	941.29	0.19	59.	269.	0.50	15.83		0.00	
0.30	941.76	0.66	63.	514.	0.92	15.83		0.00	
0.40	942.13	1.03	66.	846.	1.92	15.75		0.00	
0.50	942.30	1.20	68.	1123.	3.83	15.75		0.00	
0.75	942.69	1.59	72.	1737.	5.50	15.75		0.00	
1.00	943.05	1.95	75.	2355.	6.25	15.75		0.00	

INFLOW-OUTFLOW
HYDROGRAPH
FOR 100% PMF

Max. Inflow = 2694 c.f.s.
Max. Outflow = 2355 c.f.s.



APPENDIX D

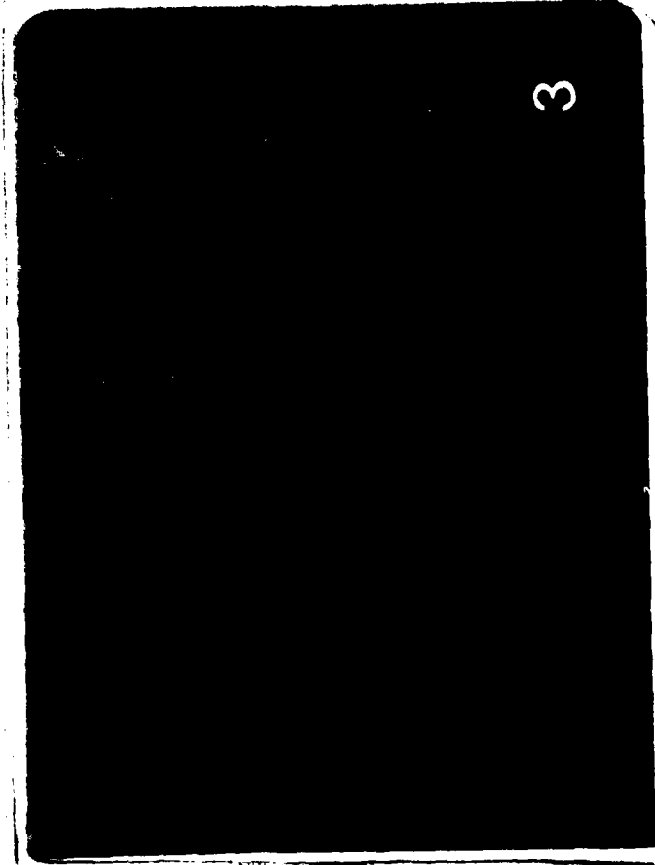
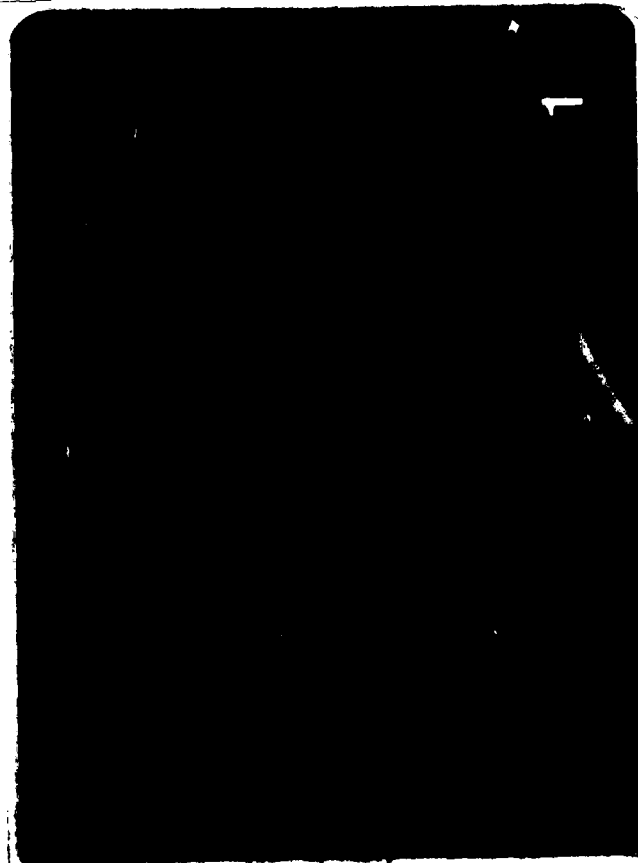
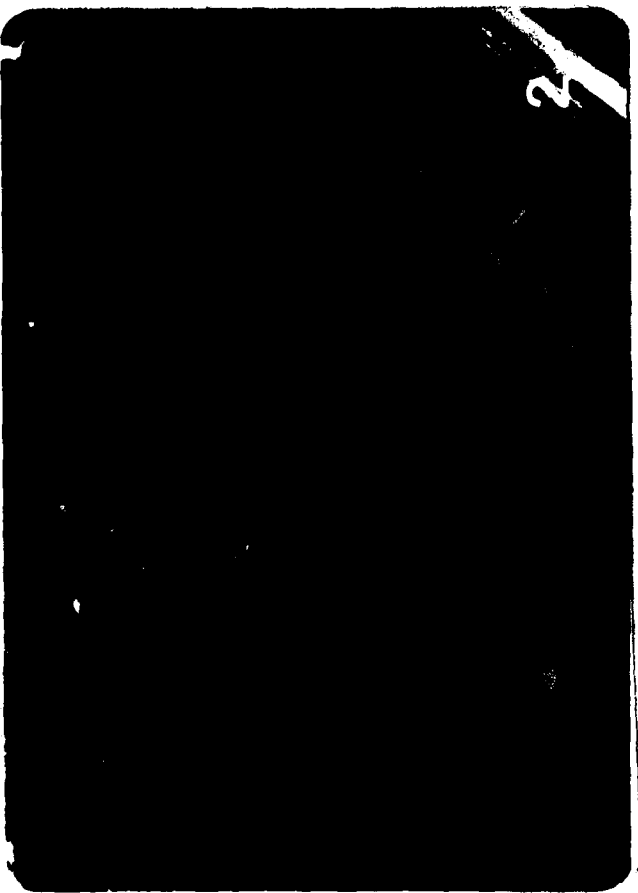


PLAN SKETCH
KEY TO PHOTOGRAPHS
DAM No. 31076

LIST OF PHOTOGRAPHS

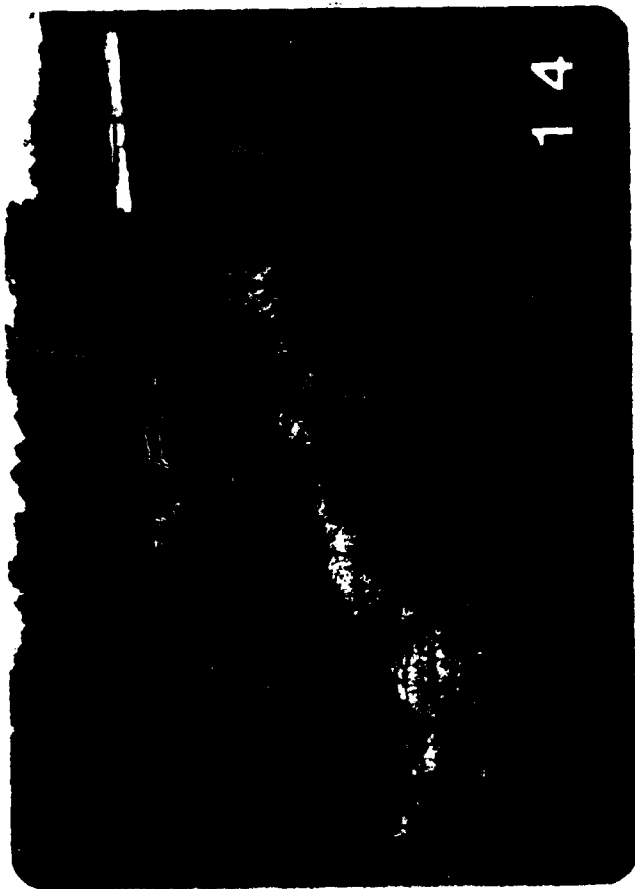
Photo No.

1. Aerial - Looking Southeast
2. Aerial - Looking West
3. Aerial - Looking Northeast Across Dam
4. Front Face of Embankment Across Emergency Spillway Entrance
5. Crest of Embankment
6. Front Face of Embankment
7. Downstream Face of Embankment
8. East Abutment Contact
9. Downstream Face of Embankment
10. Reservoir Area
11. Emergency Spillway Entrance (Note Fence Posts)
12. Emergency Spillway Entrance
13. Emergency Spillway Channel
14. Emergency Spillway Channel
15. Emergency Spillway Channel
16. Emergency Spillway Channel









14



16



13



15

